Nanoscale electro machining

NEM is one of the few techniques that allows researchers to manipulate various materials by the selection of appropriate liquid and process conditions.

The process can be used with CAD systems for automation and scaled up for mass production, and has potential applications in single DNA detection devices such as nanopores, nanoscale interconnects in biological and semiconducting devices, molecular sieves for protein sorting and nanojets for fuel or drug delivery.

Ajay Malshe, associate professor in mechanical engineering at University of Arkansas; K Virwani and Devesh Deshpaned, student researchers and K P Rajurkar of the University of Nebraska, presented their results at the International Institution for Production Engineering Research.

"With this technique, you can remove on demand precisely what you want to, where you want to remove it," Malshe said. "Simple, but very powerful."

Nano-EM is used to etch nanopores as small as 8-10nm diameter on an atomically flat gold surface. An STM with a platinum-iridium atomically sharp electrode tool, dipped in a dielectric oil medium to apply an electric field to the system was used. The tool and the surface remain 2nm apart. As a voltage passes through the system, tunnelling electrons move between tool and surface through the oil' s molecules, causing precise ejection of gold atoms, which creates tiny pores.

Currently, creating a nanopore by standard STM requires vacuum chambers. Frequently samples must be transferred between machine and examining instrument, taking time and money. This is problematic for manufacturers.

The researchers designed the system so that the STM alternates between acting as the machining system and probe. This enabled researchers to create nanopores on the surface and see the images simultaneously – an important advantage in manufacturing, as scientists can create a nanowell, and immediately determine whether or not it has the correct atomic scale dimensions.

"Our long-term goal is to create a complete nanofabrication laboratory on a microchip – machining, deposition, metrology and assembly events at nanoscale, at a given time, at a given place and according to engineering specifications," said Malshe, co-founder and CTO of NanoMech LLC, Arkansas Research & Technology Park.